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INTERNATIONAL GEOPHYSICAL COOPERATION PROGRAM--

SOVIET-BLOC ACTIVITIES

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I. ROCKETS AND ARTIFICIAL EARTH SATELLITES

"Sovetskiy Flot" Speculates on Future Trends in Space Exploration

The mastery of space has now moved far ahead because of the successes of advanced Soviet science and technology. The surface of the Moon has already been reached; extremely valuable data has been collected about the Universe; the boundless ocean of space has been visited by history's first interplanetary station; the reverse side of the Moon has been photographed; the Earth's largest artificial satellite has made more than 10,000 revolutions around our planet. After these successes it is useful to sum up the principal attainments of recent years of active storming of cosmic space.

People have long been striving to penetrate into the upper layers of the air ocean. But these attempts had little success, because scientists did not have at their disposal the lifting apparatus capable of delivering instruments to great altitudes. Things changed radically when the first research rocket was launched and lifted a half-ton load to an altitude of about a hundred km. This was accomplished in 1947. Thereafter the height of ascent began to increase by leaps and bounds. It suffices to mention that within a period of ten years the world's first artificial earth satellite had been put into orbit, and two years later a Soviet cosmic rocket delivered to the Moon's surface a pennant bearing the crest of the country of victorious socialism.

The flights of the rockets rapidly supplemented the knowledge of scientists about the high layers of the atmosphere. Our ideas rapidly changed about the ionosphere, which plays so decisive a role in the propagation of radio waves. We found out that the ionosphere does not have a layered structure, as had been assumed earlier, but is a continuous mass of ionized gas extending from a height of 60 km to 500 km or more. We supplemented our information about the distribution of pressure, density and temperature in relation to altitude. It was found, for example, that the temperature of the gas at altitudes of 400 to 500 km is 2,000 to 2,500 degrees. Due to the great rarefaction of the medium at these altitudes — its density is tens and hundreds of billions of times less than at the Earth's surface — this high temperature exercises practically no influence on the body of a rocket or satellite.

The rockets have yielded data on the short-wave ultraviolet radiation of the Sun; we had known virtually nothing about this radiation because it does not reach the Earth's surface, being absorbed by the atmosphere. This and much other important information was necessary to science and to the same important degree — to practical activities: they are used by radiomen making long-distance radio connections, by planners drawing up designs for aircraft, by engineers computing the trajectories of flight of satellite vehicles, etc.

However, rockets could not accomplish a number of investigations necessary to modern-day science: they passed too little time at great altitudes. They were unable to accomplish everything in their 3 or 4 minutes of useful flight. But with the launching of the first Soviet artificial earth satellite there began a planned and diversified study of the cosmic space surrounding the Earth.

The boundaries of the atmosphere have again been pushed outward: we now consider that the atmosphere has a greater extent and attains altitudes on the order of 2,000 to 3,000 km above the Earth's surface. At these immense altitudes the ionosphere is still completely measurable. It is clear that it is composed of ions of atomic oxygen.

A new and unexpected phenomenon has been discovered at these same altitudes: belts of high-energy particles. These particles (protons, electrons) have been captured by the Earth's magnetic field and are therefore concentrated in certain belts. Satellites have made it possible to discover the lower boundary of two such zones. To investigate their configuration it was necessary that measuring instruments penetrate through these belts, that is, travel immense distances from the Earth -- 50,000 to 60,000 km -- into the region of interplanetary space, where the influence of the Earth's magnetic field is no longer felt.

Data from the third satellite demonstrated that the equatorial inner radiation belt of the Earth consists of high-energy protons of tens or even hundreds of millions of electron-volts; interesting data were also derived in respect to the distribution of heavy nuclei in primary cosmic radiation. It has been established that the density of the upper atmosphere at levels greater than 200 km is considerably greater than was earlier assumed.

To investigate cosmic rays and the corpuscular radiation of the Sun it was also necessary to carry measuring instruments out beyond the limits of the perceptible influence of the Earth's magnetic field. After having at their disposal the experience of the development of the third earth satellite, Soviet scientists could really deal with the problem of lunar research. Then three Soviet cosmic rockets were sent into space, one after another.

The world was shaken by the unprecedented power of our rockets and the almost fantastic precision of their placement in orbit. Indeed, in order for a rocket to hit the Moon it was necessary to regulate its speed of flight with an accuracy to 1/100 %, hold the direction with an accuracy of $\frac{1}{4}$ degree for all spatial axes, and not permit the moment of launching to differ from the computed moment by more than several seconds! This is something to marvel at!

But the world was still more amazed when the third cosmic rocket was launched from the territory of the Soviet Union, sending an automatic interplanetary station along the route Earth-Moon-Earth. As is well known, the Soviet interplanetary station sent back photographs of the invisible side of the Moon. These photos enable us to answer many questions of acute interest to science: what are the details of the Moon's surface, what are the strange

white belts radiating outward from certain craters (cirques) on the Moon's surface, what is the nature of the craters themselves — volcanic or meteoric, and others.

Interplanetary space is a highly rarefied gaseous medium. On the average each cubic centimeter of space holds a total of about a hundred gaseous molecules. Therefore the interplanetary medium is freely penetrated by various radiations and especially by radiations from the Sun (electromagnetic waves and corpuscular radiation). Because of this the cosmic ocean is becoming a laboratory in which scientists can study under natural conditions all kinds of processes of interaction of radiation with rarefied matter.

But interplanetary space is not occupied by gas alone — it abounds in solid matter — meteoric particles of different sizes. Dust and larger particles play a dual role in interplanetary space: first, they can change the physical properties of the medium, increasing its temperature, changing its electrical properties, and introducing new elements into the process of interaction of radiation with the medium; second, particles with a size greater than one millimeter constitute a danger for interplanetary space ships.

These particles drift in different directions through space at speeds on an order of 30 km/sec. Because of such great velocities they possess surprising penetrating force: a particle with a radius of 0.5 mm is capable of penetrating through an aluminum sheet 1 cm thick, with a radius of 2 mm — a sheet 5 cm thick, while a particle with a 5 mm radius can penetrate an aluminum plate 11 cm thick! An encounter with such an "emissary" of space would be an unpleasant experience for an interplanetary space ship. Fortunately, the probability of such an encounter is very small; particles even with a 0.5 mm radius are encountered very rarely in interplanetary space.

On approaching the Earth, the interplanetary station of the future can accomplish "terrestrial" work. The principal task will be the study of the previously-mentioned belts of high-energy particles. By repeatedly penetrating the belts in different directions, the station can do a good job of investigating their configuration and change in time. Such work is especially important for finding safe routes in interplanetary space. The first Soviet cosmic rockets have already accomplished something in this direction. It has become clear that the belts have their maximum development around the Earth at distances of 2,000 and 20,000 km from the equator. The inner belt surrounds the planet in a broad belt, "covering" all the middle latitudes, that is, extending approximately from 60° N., to 60° S. The outer belt encircles the Earth to somewhat higher latitudes. Thus, the circumpolar regions are free of these dangerous belts that contain a large number of high-energy particles. A safe exit into outer space will evidently lie from polar "rocketdromes".

On approaching the Earth, at distances from 5,000 to 10,000 km, the interplanetary station can transmit valuable information about the ionosphere and the upper layers of the Earth's atmosphere. Near the Earth the station can make observations of a whole series of other interesting phenomena.

CPYRGHT

CPYRGHT

A remote area of the Pacific Ocean was recently reached by powerful Soviet rockets designed for scientific research. The time is not far off when such rockets will be sent on still farther travels — to the planets of the solar system. They will send back information about these distant worlds. The radio stations of these long-range explorers will transmit data to Earth about the fatal radiation that may be encountered enroute and about the condition, density and temperature of the atmosphere of one planet or another. The automatic instruments will make a detailed study of the temperature of the planet's surface, the condition and density of its soils, its radioactivity, and many, many other matters. Because of such exploratory stations Man will learn in detail about the planet under study long before the first astronauts approach it. Man will be able to discover whether or not the world they wish to visit is hospitable or not and will prepare himself accordingly for the forthcoming flight.

Numerous letters continue to arrive from the Soviet people to the address "Sputnik — Moscow"; these letters are from laborers, collective farm workers, students and members of the armed forces. Many of them manifest a readiness to assist our scientists in the exploration of space and express an admiration of their outstanding achievements.

By use of the most modern cosmic thechnology Soviet scientists have discovered and named two new seas: the Moscow Sea and the Sea of Dreams. They have also discovered craters and cirques that have been named Tsiolkovskiy, Lomonosov, Joliot-Curie, Kurchatov, Mendeleyev, Jules Verne and Popov. The day is not far off — and it will unquestionably be in our century — when Man will visit the shores of the Sea of Dreams. And we believe such men will be representatives of the new world.

("Before New Cosmic Flights", by B. Mirtov, Sovetskiy Flot, 7 April 1960, p. 4)

II. UPPER ATMOSPHERE

Aurora of a Rare Type Observed Near Leningrad

On 25 February 1959, in the vicinity of Leningrad, an intense aurora of exceptional beauty was observed in a rather rare form, especially for the latitude of Leningrad.

I chanced to observe this aurora at Zelenogorsk, 40 km to the northwest of Leningrad. The glow of electric lights over Leningrad was far to one side, the evening was clear, calm and cloudless; the conditions for observation were good.

The first traces of the aurora were noted at 1955 hours (all times in this article are Moscow time). In the northeast, at an altitude of approximately 60° , there was a small, bright, oval, weakly phosphorescent cloud. In the northwest, at the same altitude, there were two clouds, one above the other, tilted toward the horizon; the lower cloud was greatly elongated. The picture described lasted 7-8 minutes, but the brightness of the clouds constantly increased and stars of the second and third magnitude could not be seen in these sectors of the sky. The clouds were very beautiful and glowed with a delicate faint green light (it should be noted that the predominant color of auroras in the temperate latitudes is red, resembling the reflection of a distant fire). Although these phosphorescent clouds did not appreciably change their position in the sky, they appeared to be moving, even alive; this was due to a frequent, almost visually imperceptible flickering, which intensified, creating the psychological effect of antitipation of something unusual. In actuality they began to rise rapidly at 2005 hours and the raylike pillars also began to disappear rapidly. They rose from beneath the horizon, extended higher and higher, moving at the same time, and finally reached the zenith.

The aurora attained its maximum brightness and intensity at 2010-2015 hours. It seemed as if about a dozen searchlights were moving through the sky, but with this difference, that the farther a searchlight beam is from the horizon, the wider it is, whereas here the beam of light narrowed in an upward direction, as if the searchlights were situated directly over the observer's head. From time to time the column of light was seemingly cut by something similar to a colossal scissors, but after a fraction of a second it again fused into a single glowing column. The horizontal and tilted bands and clouds were no longer visible and the entire sky (except the southern sector from the horizon to the zenith) was encircled by a gigantic glowing corona; running through this corona were flickering colored waves, from a delicate greenish-yellow to a purple-lilac. The sector of the black sky in the south with the blue Sirius, reddish Betelgeuse and the string of stars called Orion's belt, emphasized the bewitching beauty of the picture.

The aurora began to weaken at 2017-2020 hours, but in the zenith the converging rays formed a bright semicircle of somewhat irregular form in the shape of a letter "C"; its angular dimensions were no greater than 1°. At 2030 hours the radiant pillars no longer reached the zenith, their color became calm, even and homogeneous, and the intervening stretches of black night sky with their bright stars became wider and wider; at 2035 hours the corona became hard to distinguish and disappeared.

Auroras are only visible at Leningrad on 5% of all clear nights (on an average for many years) and then are usually faint. The corona is most commonly observed in northerly regions, close to the geomagnetic pole, where magnetic lines of force are almost perpendicular to the surface of the Earth.

It should be noted that the aurora which we observed was not only beautiful, but extremely rare.
("Visual Observation of an Aurora in the Form of a Corona", by R. V. Abratov, Priroda, No. 12, 1959, pp. 112-113)

Measurements of Radiation During the Flight of the Second Cosmic Rocket

The apparatus for investigation of radiation carried aboard the second Soviet cosmic rocket, launched to the Moon on 12 September 1959, was designed to collect new data concerning the Earth's outer radiation belt, to record cosmic radiation along the route from the Earth to the Moon, and to discover a lunar radiation belt, if such existed.

The number of instruments and the range of measurements was greater than in the first cosmic rocket (1). In addition, a part of the radiation-recording instruments were installed outside the air-tight capsule (at a distance of 56 cm from its surface); this permitted a considerable decrease in the shielding of these instruments.

The full array of measuring apparatus consisted of 6 gas-discharge counters and 4 scintillation counters.

The following instruments were situated within the capsule:

1. Scintillation counter A (detector -- a cylindrical crystal of sodium iodide 39.5 X 40 mm in size). This instrument recorded the full ionization created by the ionizing radiation in the crystal and the counting rate of the pulses corresponding to differing energy release in the crystal: $\gg$ 60 Kev -- I threshold; $\gg$ 600 Kev -- II threshold and $\gg$ 3.5 Mev -- III threshold.

2. A gas-discharge counter 4 with operating dimensions of 1 X 5 cm, surrounded by an additional shield of copper 1.5 mm thick.

3. A gas-discharge counter 5 with operating dimensions of 1 X 5 cm, surrounded by additional shielding of 3 mm of lead and 1 mm of aluminum.

These three instruments were situated within an aluminum housing with a thickness of 1 g/cm^2. In addition, about 20% of the full solid angle was covered with thicknesses of material ~10 g/cm^2.

The following instruments were installed outside the capsule:

4. A scintillation counter B (detector — a cylindrical crystal of solium iodide 39 X 40 mm in size). This instrument recorded the full ionization created in the crystal and the counting rate of pulses, corresponding to verying energy release in the crystal: $\geqslant$ 45 Kev — I threshold and $\geqslant$ 450 Kev — II threshold. The crystal of this counter was shielded by aluminum with a thickness of 0.8 g/cm^2, while a great amount of material (up to 10 g/cm^2) was only covered by about 5% of the full solid angle.

5. A scintillation counter C (detector — a crystal of caesium iodide with a thickness of 3 mm and a diameter of 30 mm, covered on the side turned toward free space with a layer of aluminum with a thickness of 1.2 mg/cm^2). The instrument recorded the total ionization created in the crystal.

6. A gas-discharge counter 1 in a shield with a thickness of 3 mm of lead plus 1 mm of aluminum with an aperture with an area of 0.28 cm^2.

7. A gas-discharge counter 2 in the same shield with an aperture having an area of 1.6 cm^2, covered by a copper foil with a thickness of 0.2 mm.

8. A gas-discharge counter 3 in the same shield with an aperture having an area of 1.6 cm^2, covered with a copper foil 0.5 mm thick.

In addition, the apertures of counters 1, 2, and 3 were covered on the outside with an aluminum foil 0.2 mm thick. The thickness of the walls of all the counters was 50 mg per 1 cm^2 of stainless steel.

Counters 2 and 3 only operated in the belt of high intensity. After departure from this belt the corresponding telemetering channels were used for the transmission of information about the counting rate in the scintillation counters (thresholds I and II). The indicated change in the program of measurements was made at a determined intensity of radiation, for which within the capsule there was still another counter (without additional shielding). The switching of the program was adjusted to the counting rate of this counter, about 500 pulses/sec. The electronic systems of all instruments were made with semiconductors. The discriminating power of the scaling circuits and discriminators was 10^{-5} sec.

This article partially sets forth the results of the preliminary processing of measurements in the range of distances 9 120,000 km from the center of the Earth, and in the circumlunar area beginning 40,000 km from the Moon's surface.

1. Data relative to the spatial arrangement of the radiation belt. Figure 1 shows the trajectories of the first and second cosmic rockets relative to the Earth's magnetic field and the results of measurements of ionization. The rocket trajectories differ from one another to an insignificant degree: the part of the second cosmic rocket passes through the belt of high intensity by 200-300 km closer to the plane of the magnetic equator than does the part of the first rocket. The indicated displacement of the trajectory cannot be responsible for the change in form and the displacement of the apex of the curve, giving a dependence of intensity on height of flight, but only aggrevates this difference.

The general picture of deformation of the zone of high intensity for 12 September relative to its position on 2 January, amounts to a displacement of the zone in the direction of the inner regions of the magnetic field. The maximum intensity on 12 September was observed at a distance of 17,000 km from the center of the Earth on line of force 59° and on 2 January at a distance of 27,000 km on line of force 63°.

What are the reasons for the observed deformation of the outer radiation belt? It should be noted that the flights of the first and second cosmic rockets were made along trajectories extremely close to one another in respect to geographical coordinates, but substantially different relative to direction toward the Sun; this could show a systematic deformation of the Earth's magnetic field. It is more probable, however, that the deformation of the outer radiation belt is associated with the variable character of corpuscular currents from the Sun and, accordingly, with the variable character of injection of particles into the belt of high intensity. In favor of this there is the observed difference in the experiments of 2 January and 12 September in the energy spectrum of the particles and also a comparison of the general variation in intensity with data derived during the flight of the American rocket "Pioneer-3" (2). In the latter case the flight path in respect to the direction to the Sun was close to the trajectory of the first Soviet cosmic rocket, but, nevertheless, the maximum intensity was recorded at a distance of 22,000 km from the center of the Earth on the line of force intersecting the Earth's surface at geomagnetic latitude 57°, that is, in the best agreement with the data of the flight of the second cosmic rocket, and not with the first.

2. Composition of radiation in the Earth's outer radiation belt. Figure 2 shows the readings of some of the instruments in the second cosmic rocket in relationship to distance to the center of the Earth.

The counting rate of the scintillation counter with a threshold of 3.5 Mev (curve I) confirms with considerably better accuracy than on the first rocket that particles with a path of several grams per 1 cm^2 are absent in the outer belt. The small (30%) increase in the counting in the region of the maximum in this case is possibly due to superimposed pulses of lesser amplitude. Thus, a current of electrons with an energy of 5 Mev (or protons with an energy of 30 Mev) even in the maximum of the belt constitutes less than 1 part/cm^2·sec.

Substantially new data was revealed from the readings of the gas-discharge counters 4 and 5, situated within the capsule and shielded by additional filters of copper and lead (curbes II and III). The data of the scintillation counter, with a threshold of 3.5 Mev, shows that the increase in counting in counters 4 and 5 cannot be caused by charged particles penetrating through the housing of the capsule; this means that both counters are recording photons. Inasmuch as the intensity of counting in counters 4 and 5 differs by 1½ times, it is necessary to ascribe relatively high energy (more than 300 Kev) to these photons.

In principle it is possible to propose two explanations for the appearance of photons of the observed energy: 1) due to the Roentgen radiation of electrons with an energy on the order of 10^6 ev or 2) due to the bombardment of the housing of the capsule with protons with an energy of 10 Mev.

The first possibility seems the most probable at this time. But even in this case the energy spectrum of the particles (electrons) is extremely unexpected. Evaluation of the current of electrons with an energy of 1 Mev in the maximum according to the readings of counters 4 and 5 gives a value of $5 \cdot 10^5$ part/cm^2·sec; the current of electrons with an energy of 5 Mev, as already mentioned, is less than 1 part/cm^2·sec. On the other hand, in experiments in the first cosmic rocket there was discovered an extremely large current of electrons with an energy of 20 Kev, to whit: 10^{10} part/cm^2·sec. This soft part of the spectrum of the electrons was also discovered in an experiment in the second cosmic rocket with the aid of scintillation counters. In the maximum it is expressed more weakly than was true on 2 January, but nevertheless apparently gives an appreciable contribution in the readings of counter 1 (Figure 2, curve IV).

Thus, data was derived on the existence of two energy groups of particles: electrons with an energy of 20 Kev and electrons with an energy of 1 Mev (or protons with an energy of 10 Mev). Evidently the mechanism of formation of both groups is substantially different. The energy of the particles of the first group is close to the mean energy of the protons of the corpuscular currents from the Sun and this enables us to assume the establishment of a thermodynamic equilibrium between protons and electrons in the process of their intrusion into the Earth's magnetic field. On the other hand, the formation of the second group is evidently due to non-equilibrium processes. We observe that the pulses of the second group are close in value to the

pulses of the protons of the corpuscular currents, and also to the pulses of electrons arising from the decay of albedo neutrons.

3. Search for high radiation near the Moon. During the flight to the Moon, right up to a distance of 1,000 km from its surface, there was not discovered any increase in the intensity of radiation within the limits of the 10% of cosmic background. The receipt of precise data in the range of distances from 0 to 1,000 km from the surface of the Moon was made difficult by the brevity of the flight in this sector, but even at these heights no considerable increase in intensity was discovered.

If we compare the intensity of radiation in a hypothetical lunar radiation belt in relation to the maximum of the Earth's outer belt from the readings of the most sensitive detectors of soft radiation — scintillation counters, then for heights 1,000 km we get a ratio of intensities of 10^{-6} or less, for heights of 0 1,000 km —10^{-4} or less. Thus, it may be assumed that to all intents and purposes a lunar radiation belt does not exist.

4. Measurement of intensity of cosmic rays. After departure from the Earth's outer radiation belt (beginning with a distance of 70,000 km from the center of the Earth) and in the circumlunar sector, all the instruments recorded constant intensity. The arrangement of part of the instruments outside the capsule gave a perceptible result in the sense of a decrease in the contribution of secondary radiation formed under the influence of cosmic rays in the surrounding material. Figure 2 shows the results of measurement of ionization within the capsule (curve V) and outside the capsule (curve VI). If within the radiation belt curve VI is considerably higher than curve V, due to the absorption of relatively soft radiation, then outside the belt of soft radiation the effect, as might be expected, is the reverse. A similar result was derived by using other parameters. A summary of data of the intensity of radiation outside the Earth's magnetic field is given in Table 1.

Table 1(2)

Date	Location of the instrument	Gas-discharge counters	Scintillation counters		Ionization in crystal weighing 180 g (ev/sec)
		intensity (part/ $cm^2 \cdot sec$)	threshold energy (Kev)	intensity (4)	
2 January 1959	Inside capsule	$2,3 \pm 0,1$	4500 450 45	$1,9 \pm 0,1$ $3,0 \pm 0,15$ $6,75 \pm 0,3$	$(1,42 \pm 0,05) \cdot 10^9$
12 September 1959	Inside capsule	$2,46 \pm 0,1$ (2) $2,46 \pm 0,1$ (3)	3500 600 60	$2,12 \pm 0,1$ $2,77 \pm 0,15$ $6,7 \pm 0,3$	$(1,55 \pm 0,05) \cdot 10^9$
12 September 1959	Outside capsule	$1,98 \pm 0,1$ (3)	450	$2,02 \pm 0,1$	$(1,15 \pm 0,05) \cdot 10^9$

(1) The errors characterize maximum scattering in the area of the detectors. (2) Counter with additional shield of 1.5 mm of Cu. (3) Counter with additional shield of 3 mm of Pb. (4) Indicated is the number of pulses per second, related to a unit area of the crystal (19 cm^2).

Cited Literature

(1) Vernov, S. N., A. Ye Chudakov, P. V. Vakulov, Yu. I. Logachev, DAN, 125, 304, 1959.

(2) Van Allen, J. A., and L. A. Frank, Nature, 183, 430, 1959.

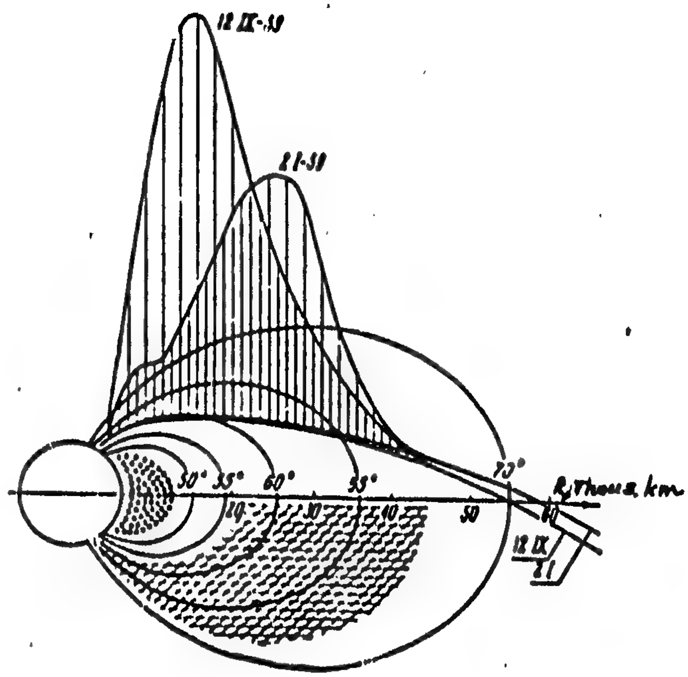

Fig 1. Trajectories of the rockets relative to the Earth's magnetic field. The vertical lines resting on the trajectories represent the intensity of radiation at a given point of the trajectory. In the drawing, the magnetic force lines are shown intersecting the surface of the Earth at the geomagnetic latitudes 50, 55, 60, 65, and 70 degrees (the magnetic field is assumed to be the field of a dipole of a geomagnetic pole with the coordinates 78.5 N and 69 E.

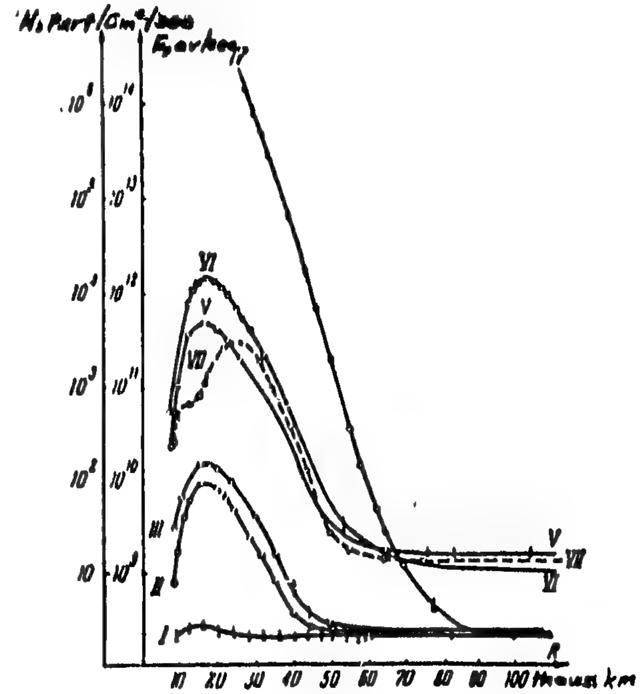

Fig 2. The relationship of the intensity to the distance to the center of the Earth. I, III-threshold of scintillation counter A; II, counter 4, with a 1.5 mm copper screen (inside the container); III, counter 5 with a 3 mm lead screen; IV, counter 1 with an aperture diaphragm made of 2 mm thick aluminum (inside of the zone the area of the diaphragm was taken as the effective area); VI, ionization in crystal B; VII, ionization according to the data of the first cosmic rocket.

("Measurements of Radiation during the Flight of the Second Cosmic Rocket", by S. N. Vernov (Corresponding Member of the Academy of Sciences of the USSR), A. Ye Chudakov, P. V. Vakulov, Yu. I. Logachev, and G. Nikolayev, Doklady Akademii Nauk SSSR, Vol. 130, No. 3, 1960, pp. 517-520) ✓ ditto

Observatory of the Future

The road rose higher and higher into the mountains. No, it is not an ordinary highway or path snaking its way between mountain ridges. It is like a high-voltage line running from mast to mast in the form of steel cables. Small colorful cars are speeding along them.

The familiar landscape of the earth was now far below. At this altitude everything looks grimmer: great mountains covered with gray snow caps and frightening yawning precipices frequently resounding with the echo of powerful avalanches... And now the clouds are also below. The air appears clear and light. The car is rushing upward like a tireless alpine climber. And suddenly around the bend...

An unusual structure, resembling the legs of a mythical giant striding through the mountain canyons, hove into view. It rises into space like the ancient Tower of Babel suddenly come alive.

One might say that the traveler has almost reached his destination. But here the traveler changes from the wagon to a fast elevator rising higher and higher within a ferroconcrete shaft of an odd-looking tube. Hundreds of meters flow past in the opposite direction and we finally find ourselves in a huge transparent sphere. The latter, like the cockpit of a high-flying plane, has its own temperature, and the people in it feel quite comfortable.

The open girder interlacement presents a strange pattern, and the gigantic concave mirror adds to the fantastic sight. But where are we? In a high-altitude observatory close to the future.

The reader might ask: what is the use of such a structure? Why raise an observatory all the way above the clouds? The point is that the earth's atmosphere makes astronomical observations difficult — the air is not as clear as it may appear at first glance. Enormous quantities of dust specks, air streams and, finally, the clouds floating in the skies prevent the astronomers from performing their duties. No wonder that for many years they have been trying to get up as high as possible.

Wouldn't the peak of a mountain be high enough? It undoubtedly would, but it is still better to have the telescope installed not on the mountain itself but on a high tower. This precludes the influence of the mountain massif on the development of intensive air streams, dust and other interferences.

But the miracle of the observatory above the clouds will be the telescope itself. The Palomar Observatory telescope in the U.S. with its 5-meter diameter mirror was considered the largest in the world.

A still more powerful telescope is being projected and planned in our country. Its mirror will have a diameter of six meters. Soviet scientists have found quite a few original and new solutions to the problem. These have already been manifested in the design of a telescope with a 2.7-meter mirror (for the Crimean astrophysical observatory) and a model telescope with a 0.7-meter diameter (for the Pulkovo observatory). The optical system of the telescope of the future observatory has an enormous separative power — hundredths of a second of arc. The precision of the polished parabolic mirror will be striking, one 20th part of a micron. Unlike the mirror of the Palomar Observatory telescope which is made of glass, ours will be made of steel. If the American reflector weighs 20 tons, the soviet reflector will weigh twice as much. But the telescope itself will be half as heavy: the total weight of the Palomar telescope is 1,000 tons, and ours will weigh 470 tons. It will be equipped with a system of photo-electric transformers which will be controlled by an electronic computer. The soviet telescope will be the largest astronomical eye in the world. With this telescope it will be possible to observe the flight of satellites and space rockets, to study the moon and the planets of the solar system and penetrate the mysteries of the astral universe.
("Observatory of the Future", unsigned article in Znanya ta Pratsya, Kiev, No. 4, April 1960, page 17)

Study on Meteor Trail Formation

The distribution of ionized gas during the passage of meteor through the upper layers of the atmosphere is considered by V. P. Dokuchayev, Scientific Research Institute of Radiophysics as Gor'ky University, in an article in a recent Soviet scientific periodical. A solution for the diffusion equation, assuming the existence of a source of ions moving with a constant velocity at a small angle to the horizon, is found. It is shown that the concentration of plasma near the moving meteor is considerably higher than in the rest of the trail. The conditions for which the trail can be approximated by a cylinder with Gaussian distribution for concentration of plasma with radius were found. ("The Formation of an Ionized Meteor Trail," by V. P. Dokuchayev; Moscow, Astronomicheskiy Zhurnal, Vol 37, No. 1, 1960, pp. 111-114)

III. METEOROLOGY

Inter-Republic Conference of Weather Forecasters Held in Tashkent

Is it possible to develop precise methods for the prediction of such phenomena of nature as strong winds, dust storms, thunderstorms and mist that are so harmful for the national economy? An affirmative answer to this question has been given by participants at an Inter-Republic Conference on Regional Weather Forecasting which terminated in Tashkent on 2 April. Participants declared that the development of such methods is a matter for the years immediately ahead.

The participants at this conference held at the Central Asiatic Scientific Hydrometeorological Institute, included: workers of the administrations of the hydrometeorological services of the republics of Central Asia and Kazakhstan, leading scientists of Moscow and Tashkent, representatives of the Main Administration of the Hydrometeorological Service of the USSR and the Main Geophysical Observatory.
("Inter-Republic Conference of Weather Forecasters", Pravda Vostoka, 3 April 1960, p. 4)

Newspaper Report on Soviet Meteorological Balloon

At 0645 hours the balloon "SSSR VR-75" rose into the air from the staging area of the air navigation base of the Central Aerological Observatory.

The following persons occupied the open gondola of the aerial balloon on its long flight: S. Semin, pilot first class, A. Kuleshov, aircraft radioman, and F. Cheremisin, a scientific worker at the observatory.

The crew of the aerial balloon was faced with the task of maintaining an altitude of about 1,000 meters for 10 to 12 hours; during this flight they were to conduct scientific observations for the study of air currents.

The wind caught the balloon as soon as it was aloft and carried it in a northeasterly direction. Radio communications were established with the balloon within a few minutes. A radiogram was soon received in which the aeronauts reported that the air temperature was -20° at an altitude of about 1 km.

At 1200 hours the balloon passed Noginsk and continued to drift eastward. Several experiments have already been made and have proven successful.
("Flight of the Balloon 'SSSR VR-75' ", Vechernyaya Moskva, 7 April 1960, p. 1)

Radar data and certain other data have led certain other authors to the conclusion that the liquid water content in cumulus congestus, shower and thunderstorm clouds does not exceed 8 to 10 g/m^3, and on the average is 2 to 4 g/m^3. These data cannot be regarded as indisputable because no direct measurements of water content in cumulus congestus and hail clouds have been made; indirect methods of determining liquid water content suffer from many inadequacies. In calculations of the water content of clouds of this type no allowance is made for gravitational coagulation and change in the velocity of vertical currents with height; as a result, computed data of the water content of a cloud in comparison with the amount of falling precipitation have been considerably underestimated. Therefore the problem of the investigation of liquid water content in cumulus and cumulus congestus clouds is of unquestionable interest, if only for the prediction of amounts of possible shower precipitation and for the development of physically based methods for influencing them.

Let's try to compute the maximum liquid water content in cumulus congestus clouds, using as a point of departure the velocity of vertical currents by height

(F) (1)

where $W(z)$ — the velocity of the ascending current at the level z; a — the gradient velocity in m/sec·km; W_0 — the initial velocity when $z = 0$; z_1 — the level of maximum vertical velocity; the initial point of the z axis is at the Earth's surface.

There is a considerable accumulation of moisture near the top of the cloud above the level of maximum velocities during the process of development of cumulus and cumulus congestus clouds[1]. The weight of the accumulated moisture, acting on the rising currents, decreases the magnitude of the vertical velocity; as a result, precipitation begins to fall and rising currents cease in the zone of falling. The liquid drop fraction accumulated in the upper part of the cloud seemingly "pours" out, "washing" away the lower fine-drop fraction. This is responsible for the brevity of the fall and the intensity of shower precipitation.

The equation for the movement of rising air masses, the weight of the water per unit volume considered, but without friction taken into account, is written in the form

(F) (2)

where W — velocity; ρ_B — the mass of air per unit volume; g — acceleration of the force of gravity; T' — the temperature of the cloud; T — the temperature of the surrounding medium; z — height; q — the liquid water content of the cloud in g/cm^3. Since we are interested in the maximum water content found in the center of a cloud, and since data from prior investigations[3] show that the

vertical velocity in the central part of a cloud changes only insignificantly in the horizontal plane, for the central part of the cloud dW/dt = W/dW/dz. The water content in the lower part of the cloud, as experiments show, is 0.1-$0.7 \cdot 10^{-6}$ g/cm^3 up to the level of maximum velocities[1], whereas at the level z_1 it attains its maximum value.

Let's assume that above the level z_1 the water content decreases linearly to the top of the cloud (z_B). Considering that the water content in the top of the cloud is $q(z_B) = 0$, we get

(F)

where σ — the water content gradient by height (we are examining stationary distributions of water content, so that the process of change of water content transpires far more slowly than the process of uplift of air masses).

Proceeding on the basis of the above, equation (2) can be reduced to the form

(F) (3)

Integrating this equation, taking into account the change q with height, designating the value of computed velocity determined from equation (2) without consideration of water content W_p, we get

(F) (4)

Since (F) , then from equation (4) we get for W^2

(F) (5)

To facilitate computations we estimate the mean water content of the cloud at a range of altitudes from z_B to z_K, at which $W(2) = V_K$, where V_K — the velocity of the vertical currents supporting drops with $R = 2.5$ mm, at which size spattering begins. In this case the solution of the equation (4) assumes the form

(F) (6)

From the equation (6) we get the mean value of the water content of a cumulus congestus cloud if we assume that

(F) (7)

where W_{pm} — the computed maximum velocity of vertical currents at the level z_1,

(F) (8)

The falling of precipitation from a cloud can occur only in a case if at all levels, and consequently at the level of computed maximum velocity, the real velocity of the rising currents becomes less than V_K. It is known [4] that at heights of 3 to 4 km the value for V_K is about 10 m/sec. Thus, the maximum possible mean water content of a cloud is determined by the ratio

(F) (9)

The amount of falling precipitation per 1 cm^2, without consideration of the coagulation of drops in the lower part of the cloud and the evaporation of falling drops from the lower boundary of the cloud to the earth's surface is:

(F) (10)

An analysis of the equation shows that the mean water content of the cloud -- when the maximum vertical velocities are the same -- is the greater the more rapid is the decrease in the value of the speed of the vertical currents. The decrease is determined by the stratification of the atmosphere.

Equation 10 shows that on the basis of the above assumptions the amount of falling precipitation depends on the square of the mean velocity (F) and does not depend on the size of the cloud.

The water content, computed by this method, using data derived by atmospheric sounding, exceeds the value for water content derived by other authors. Direct measurements of the microstructure and water content of cumulus and cumulus congestus clouds in 1958 on the Alazan Expedition by means of an aerial trap, showed that in the upper part of a cumulus congestus cloud the water content can vary from 20 to 30 g/m^3; this agrees well with computed data.

From equation 10 we get the following values for the amount of shower precipitation on days with hail:

W. m/sec	15	20	25	30	35	40	45
Q, mm	2,0	4,5	7,5	11,0	15,0	18,5	24,0

The cited computations of the amounts of precipitation falling from clouds give fair agreement with experimental data, although these values require further checking because of the inadequate number of experiments.

Proceeding on the basis of work (1) and equation (2), it is possible to predict not only the possibility of the falling of hail, but also the amount of hail and shower precipitation and the sizes of the hailstones.

If the level of the 0° isotherm lies near or below the zone of maximum rising currents, the size of the falling hail is determined by the value of the maximum velocity of the rising currents W_m. If, however, the 0° isotherm lies above the zone of maximum velocities, the dimensions of the hailstones are determined by the value of the vertical velocity at the level of the 0° isotherm.

Let's cite the results of investigations of the thawing of hailstones falling through a 4-kilometer thick layer of air ($t=0$ at a height of 4 km, and $t= 20^{\circ}$ at the earth's surface; R — the radius of the hailstone):

$R_{initial}$, cm	2	1	0.7
R_{final}, cm	1.75	0.65	0

As follows from these data, the greater the initial radius of the hailstone, the less (all other conditions being equal) will be its change in radius as a result of thawing when falling below the 0° isotherm.

Using data based on radiosonde observations in the atmosphere, the conclusions cited in work (1), the equation (1), and the above-cited results of investigation of hailstone thawing, it is possible to predict the probability of the falling of hail, the possible amount of precipitation and the final dimensions of the hailstone.

A checking of this method by the use of data from past years yielded positive results.

--El'brus High-Mountain Complex Expedition,
Institute of Applied Geophysics of the Academy of Sciences of the USSR

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("Liquid Water Content of Shower Clouds and Some Problems of Shower Precipitation Forecasts", by N. Sh. Bibilashvili, et al, DAN, Vol. 131, No. 3, 1960, pp. 549-551) ✓ ditto

IV. OCEANOGRAPHY

Oceanographic Conference Held in Moscow

A plenary session of the Oceanographic Commission of the Presidium of the Academy of Sciences of the USSR was held several days ago. Several dozen reports and communications generalizing the principal data collected by Soviet scientists in the field of prediction and computation of physical phenomena in the ocean were discussed at this session.

An expanded session of the Oceanographic Commission ended yesterday. Over a period of three days the scientists and representatives of the navy and fishing industry discussed the results of the work of the First International Oceanographic Congress. The following persons appeared at the session and presented reports reviewing the present-day status of individual problems of oceanographic study: L. A. Zenkevich, Corresponding Member of the Academy of Sciences of the USSR; Professor A. G. Kolesinkov; M. V. Klenova; A. I. Duvanin; V. V. Timonov; the scientific workers B. A. Neleppo. L. M. Fomin, Ye M. Suzyumov and others.

A resolution was adopted encouraging the continuing development of Soviet oceanography.
("Conference of Oceanographers", Sovetskiy Flot, 27 March 1960, p. 4)

Press Report on the Voyage of the Oceanographic Research Vessel "Vityaz' "

The Vityaz' has visited interesting islands in the Southern Hemisphere. The expedition visisted there for the accomplishment of one of its most important tasks — the investigation of corals, so abundant in those regions of the Indian Ocean.

At the port of Tamatave on the island of Madagascar, where the Malagasy Republic was proclaimed two years ago, the Vityaz' was met by hundreds of Frenchmen and citizens of the Malagasy Republic. They expressed their deep feelings of friendship for the Soviet people. Representatives of various classes of the population, after examining the scientific floating laboratory, invited participants on the expedition to be guests in their homes.

The French scientists proposed a visit to the oceanographic station on the island of Nossi-Bé. The station workers, after becoming acquainted with the work accomplished on our expedition, expressed special interest in the discovery of a new submarine mountain.

This discovery occurred at the time of routine research in the western part of the Indian Ocean. The echo sounding apparatus, continually in operation, suddenly indicated a sharp decrease in depth — from 4½ kilometers to 1½. Careful measurements of depth confirmed the presence here of a mountain three kilometers high.

The workers at the oceanographic station organized an excursion through the island for our benefit. The island resembled a botanical garden. They showed us plantations of coffee, black pepper and vanilla. We also visited plantations of iland-ilang — an aromatic plant whose yellow flowers yield volatile oils for perfumery.

Chameleons were included among our souvenirs. These little animals felt fine in their unusual marine surroundings. They calmly wandered through the cabins, surprising everyone with their sudden changes in color.

On the nearby little island of Nossi-Komba, in the coral reefs, the members of the expedition observed some lemurs, interesting inhabitants of the tropical forests of Madagascar (lemurs are downy monkeys with long tails). Two lemurs joined the complement of four-legged travelers on the expedition.

After several research stops ("stations") in the Mozambique Channel, the Vityaz' approached the Comoro Islands. The ichthyologists were especially eager to visit these islands because they are the home of the extremely rare crossopterygii fish.

Our vessel visited the port of Dzaudzi — the administrative center of the Comoro Islands. The members of the expedition became acquainted with the local countryside, where there are enclosures instead of houses and the furniture is woven of palm leaves. A week later we entered the part of Zanzibar and were greeted with the strong aroma of cloves.

We saw many interesting things in Zanzibar, an old Portuguese port: the house in which the famous explorer Livingston lived, the agricultural experiment station, and the ruins of the ancient palaces of the sultans. The traces of a slave camp can still be seen not far from the city.

In the Southern Hemisphere the expedition also called at the Seychelles Islands — the home of the Seychelles palm — the only of its genus. It has a fruit weighing as much as 40 kilograms.

The last month was exceedingly busy for the expedition: the Vityaz' made 45 stops — oceanographic stations; hundreds of samples of water and dozens of samples of the sea bed were taken at these stations and a great number of chemical analyses and observations were made.

CPYRGHT

The Vityaz' will soon arrive at Bombay, and will thereafter begin the final stage of its work while enroute to its native shores.

("To Home Shores", by L. Khitrov, Vechernyaya Moskva, 7 April 1960, p. 6)

Report on the Atlantic Voyage of the Research Vessel "Lomonosov"

The scientific research vessel Mikhail Lomonosov arrived in the port of Kaliningrad yesterday from its Atlantic voyage. The chief of the expedition, V. K. Agenorov, Candidate in Geographical Sciences, issued the following statement:

"The Mikhail Lomonosov has completed a 100-day expedition in the western and northwestern Atlantic in fulfillment of the objectives of the Marine Hydrophysical Institute of the Academy of Sciences of the USSR. Included in our research was the study of wave action, hydrology, hydrodynamics, radioactivity, chemistry, biology, and marine geology".

"Along the entire 13,000 mile route we made 132 brief stops, although many lasted several days. For a distance of 10,000 miles we made measurements of depths as great as 5,500 meters. We took several cores of bottom material with a length of several meters each for the purpose of determining the age of the Atlantic Ocean. Valuable information was derived on the propagation of light at great depths in the ocean".

"Our meteorologists recorded exceptionally high cyclonic activity in the North Atlantic in relation to past years. Collected data on this subject will be studied in greater detail".

"At the request of the Institute of Oceanography of the Berlin Academy of Sciences (German Democratic Republic) our expedition was accompanied by a group of German scientists who adhered to their own research program".

"At Halifax (Canada), where we took a brief rest, our ship was visited by more than 1,500 local residents, including many scientists and delegates of the congress. The guests manifested great admiration for the well equipped ship's laboratory".

("One Hundred Days in the Atlantic", Sovetskiy Flot, 17 April 1960, p. 2)

Manganese Concretions on the Floor of the Northeastern Pacific

The following is the full text of an oceanographic report appearing in the Doklady Akademii Nauk SSSR.

Manganese formations are very widely encountered in the floor deposits of the northeastern part of the Pacific Ocean. Manganese dioxide is encountered in the form of manganese concretions in various forms and sizes, manganese incrustations covering fragments of sedimentary and volcanic rocks, nodules of manganese scattered in strata of red clay, and finally, in the form of individual lenses of manganese at various depths in core samples of bottom deposits. Nodules of manganese of sand or gravel size are a common constituent of deep-water red clays and are found in many core samples.

The presence of manganese concretions in the northeastern part of the Pacific Ocean was mentioned for the first time in a work by Murray and Renard (5), based on data from the expedition that sailed aboard the "Challenger". In recent years the widespread distribution of manganese incrustations and concretions on the submarine highlands in the northeastern part of the Pacific Ocean has been noted in works published by associates of the Scripps Institute of Oceanography (1-3).

Manganese concretions have been discovered in the zone of development of red clays (Figure 1). The maximum amount of manganese concretions was encountered in the central deep-water part of the northeastern basin of the Pacific Ocean at depths of 5,000 to 6,000 meters. Their extensive development has also been observed along the American coast in the region of the Murray and Mendocino faults at depths of 4,500 to 5,000 m and to the south of the Murray fault, between 25 and 20° N., at depths greater than 3,500 m. The northern boundary of development of manganese concretions near the American coast passes approximately along the Mendocino fault at 40° N., while in the region of the central part of the basin it is at 45° N. Only very small individual concretions are found to the north.

The distribution of manganese concretions and incrustations in the northeastern part of the Pacific Ocean is shown in Figure 1; the map shows the data for the Vityaz', but also for the stations of the "Challenger" and the Scripps Institute of Oceanography.

Manganese concretions were discovered at 27 of the 46 stations of the Vityaz' in the region in which red clays are developed. Concretions were encountered most frequently in the central part of the northeastern basin of the Pacific Ocean, where concretions were discovered at 8 out of 9 of the stations. Following in frequency was a region situated to the east of the Hawaiian Islands, between 25 and 20° N. Concretions were discovered at 2/3 of the stations in that area. Concretions were encountered at 1/3 of the stations near the American coast in the region between the Murray and Mendocino faults.

Interesting data were derived on the basis of computations of the areas occupied by concretions on the sea floor. In the region between 25 and 20° N.,

to the east of the Hawaiian Islands, 8 samples were dredged from the bottom. The area of one bottom-dredged sample was 0.25 m^2, while the area of 8 samples was 2 m^2. The area of concretions collected in the surface layer of deposits in the 8 bottom-dredged samples was 0.1665 m^2. Thus, 1/12 of the area of the surface of the sea bottom in this region was occupied by manganese concretions. But there is an uneven distribution of concretions within the limits of this area. The area occupied by concretions in the various bottom-dredged samples varied from 12 to 625 cm^2.

The determination of the area occupied by manganese concretions in the bottom dredge was accomplished in the following manner. The manganese concretions in the surface layer of the bottom-dredged sample were first collected and compactly laid out on graph paper; the area they occupied was then calculated.

An interesting peculiarity of the distribution of concretions is their close relationship with the character of the relief. The manganese concretions of the northeastern part of the Pacific Ocean are developed in a zone of dissected relief. This coincidence is not accidental. The dissected character of the relief and the extensive development of concretions is evidence of the slow rate of sediment formation — one of the necessary conditions for the growth of manganese concretions. At the same time, the decomposition of the volcanic rocks outcropping in the zone of dissected relief is, in all probability, one of the sources of the manganese (2).

The form and size of the concretions within the limits of the northeastern part of the Pacific Ocean also varies sharply. We encountered concretions from several mm to 18 cm in diameter, but most commonly their average size varied from 3-4 to 5-7 cm. The concretions are oval, sometimes spherical, potato-shaped, kidney-shaped or pancake-shaped and very often are of a fantastic shape. In the central part of the northeastern basin at station No. 4,090 there were oval, sometimes spherical concretions, less commonly kidney-shaped, of a maximum size for this region, from 3-4 to 10-12 cm, most commonly 5-6 cm (Figure 2a). To the north of stations Nos. 4,074-4,104 there were smaller oval and kidney-shaped concretions from 1 to 7 cm, most commonly 3-4 cm in diameter (Figure 2b). Near the northern boundary of development of red clays the dimensions of the concretions decreases to 1-1.5 cm in diameter (stations Nos. 4,070 and 4,068). Large concretions were also discovered in the region between the Murray and Mendocino faults. Here the majority of concretions are from 6-7 to 10-12 cm, potato-shaped, flat, and more rarely — spiral shaped. To the south of the Murray fault, to the south of 25° N., most concretions are small, pancake-shaped or oval, from 1.5 to 5-6 cm, but most commonly from 3 to 4 cm.

The majority of the manganese concretions have a nucleus. Simple oval, egg-shaped and sperical concretions usually have one, sometimes two nuclei.

Complex kidney-shaped and fantastic forms of concretions have multiple nuclei. Rather often the concretions have no nuclei. The nuclei of the concretions consist of nodules of pumice, volcanic and sedimentary rocks, and less commonly of sharks' teeth and the earbones of whales. The sharks' teeth and whale earbones were usually well preserved in the concretions which we encountered. The nuclei of volcanic and sedimentary rocks had very often changed markedly, to clayey material, and in some cases had been completely replaced by manganese dioxide.

An examination of a great quantity of concretions has shown that their form depends not only on the presence of one or more nuclei situated close to one another during the formation of the concretions, but also on the character of the nucleus itself. Oval, egg-shaped or potato-shaped concretions are usually formed around nodules of volcanic rock. Concretions with nuclei of sedimentary rocks are usually flat. Oval concretions are formed around sharks' teeth; less commonly sharks' teeth serve as the nucleus for pancake-shaped formations.

The distribution of concretions is not linked to the surface of the sea bottom. As the authors (4) of the material for the Downwind Expedition in the southeastern part of the Pacific Ocean have noted, small manganese concretions were situated at a depth of 8-11 cm from the bottom surface, in 6 cases at a depth of 48-72 cm. No concretions were encountered at greater depths. Our concretions — varying in size from 1 to 6.0 cm in diameter — were encountered in 8 cores to depths of 288 cm.

The presence of concretions in different horizons of the cores indicates the development of processes of formation of manganese concretions over a prolonged geological period.

Together with the nodules and concretions one of the widely developed forms in which manganese dioxide is found in the ocean are the manganese incrustations covering bedrock outcropping at the bottom of the sea or covering boulder-pebble material.

Finally, at three stations on the 29th voyage of the Vityaz' (Nos. 4,199, 4,261, and 4,279) lenses highly enriched with manganese were encountered in the cores of red clay and silty-clay ooze. These were black, very pronounced lenses with a thickness from several millimeters to 1.5 centimeters. At station No. 4,199, at a depth of 36.5-47 cm under a cinnamon-colored clayey mud, there lay an ocher-colored very dense clay; passing through the upper part there was a lens of manganese 1.5 cm in thickness. In addition, there were several millimeter-thick manganese lenses and individual nodules of manganese in the clay. At station No. 4,241, in a stratum of reddish-cinnamon colored dense clayey mud at depths of 82-86 cm and 125.5-130 cm,

there were layers of a light cinnamon color of very dense clay with lenses of manganese 1 cm thick. At station No. 4,279, in a chocolate-colored clayey mud, there were layers (169-188 cm) of a grayish-yellow dense clayey mud with two lenses (1.5 cm thick) of ocher-colored clay with thin flakes of manganese.

The presence of horizons of dense bright yellow clay with lenses of manganese in a stratum of reddish-cinnamon and chocolate clayey muds is evidence, it seems to us, of the redistribution of manganese in the process of diagenesis.

Table 1

VERTICAL DISTRIBUTION OF CONCRETIONS IN RED CLAY CORES

No. of Station	Depth at which situated, in cm	Number of concretions	Diameter, cm	
4196	129-134	2	5	Pancake-shaped
	283-288	1	5	Kidney-shaped
4201	36-38	—		—
	42-49	2	4-5	Kidney-shaped
	49-55	small scattered concretions	0,5-1	—
4207	263-267	1	4	Oval
4249	140,173,229	—	1-1,5	Oval
4261	73	1 fragment	2,5	Kidney-shaped
4273	71-86	3	5-6	Oval
	119-125	1	5,5	Oval
4285	0-15	small scattered concretions	1,5-2	—
4293	64-67	1	3	Oval

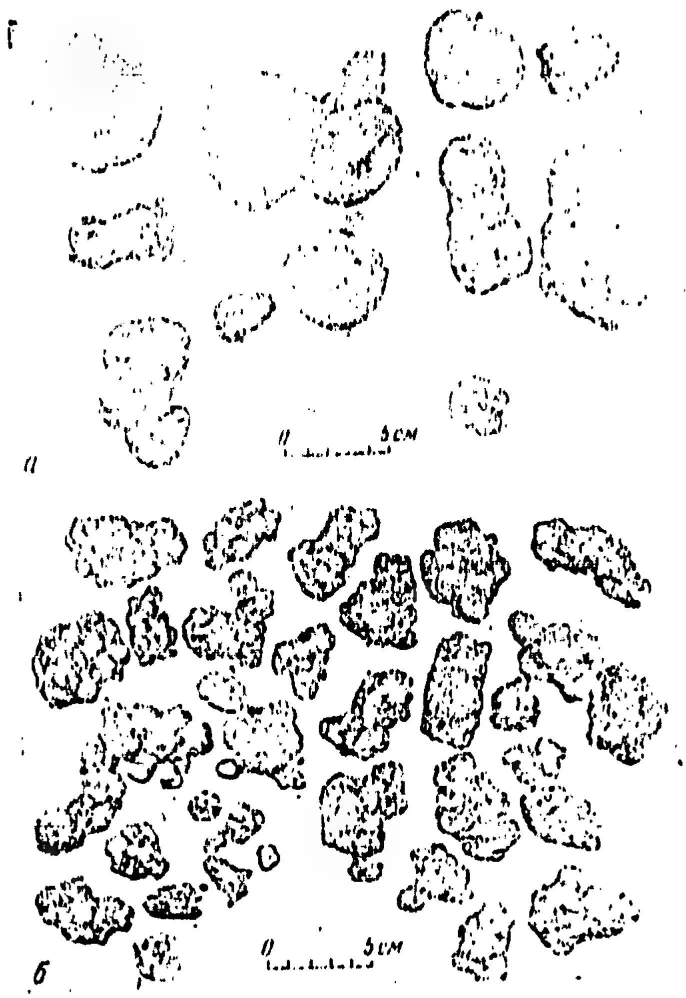

Fig 2. Manganese concretions. (a) from station No 4090, (b) from station No 4074

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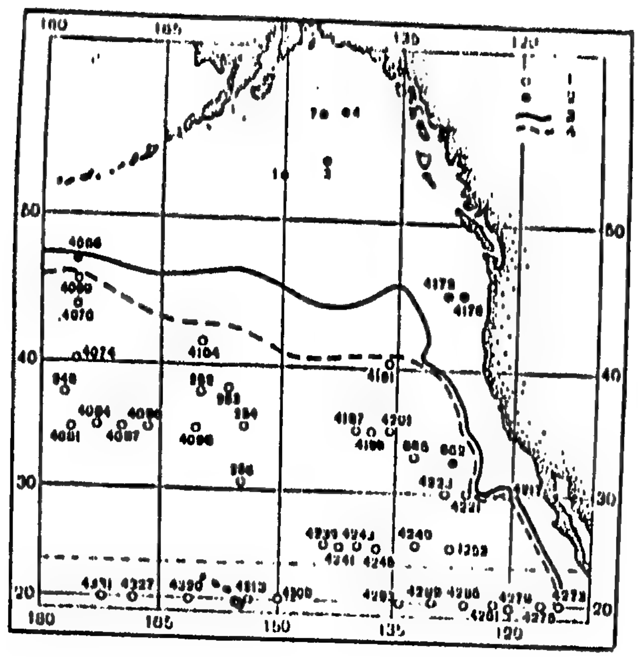

Fig 1. Chart of the distribution of manganese nodules. (1) manganese nodules, (2) manganese crusts, (3) boundary of the occurance of manganese nodules. The numbers on the chart indicate the numbers of the stations: 4066-4331 of the Vityaz', 241-258 of the Challenger, 1-7 of the North Holliday, 662-665 of ships of the Scripps Oceanographic Institute.

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("Manganese Concretions in the Deposits of the Northeastern Part of the Pacific Ocean", by N. S. Skornyakova, Doklady Akademii Nauk SSSR, Vol. 130, No. 3, pp. 653-656) ← ditto f

V. SEISMOLOGY

Report on Earthquakes on Kamchatka

On 4 May 1959 at 1916 hours (local time) the residents of Petropavlovsk were witnesses to an intense earthquake. According to the data of the seismic station "petropavlovsk", the earthquake epicenter was situated beneath the floor of the Pacific Ocean at a distance of 160 km from the city, at approximately 52°48' N., and 161°05' E.

On the basis of appearances and the resulting effects, the earthquake has been estimated at intensity 7-8. It exceeds all earthquakes observed on Kamchatka during the last 35 years.

Secondary earthquakes were recorded by the seismic station between 5 and 12 May; they were felt in that city with an intensity somewhere between 3 and 5. Their epicenters were situated in other regions of the Kamchatka seismic zone — to the south and north-northeast of the city, at distances of approximately 60 to 100 km, and also beneath the bottom of Kronotskiy Bay — at a distance of 180 km.

The following phenomena were observed during and after the earthquakes. New springs with a considerable amount of suspended volcanic ash appeared in the vicinity of the Kamchatka State Farm. The water temperature increased by 3° at the Paratunskiy hot springs. There were slides of soil and rock on the steep slopes of Nikol'skaya Mountain facing Avachinskaya Bay. There was earth creep in granular material along the shores of Avachinskaya Bay. Observers from Cape Signal'nyy and Cape Shipunskiy reported chaotic wave action in the bay and ocean: small standing waves were noted on the surface of the water. Similar phenomena in the ocean were observed by fishing vessels situated at considerable distances to the east and southeast of the epicenter. The records of the tidal gage in the port of Petropavlovsk show that a weak tsunami approached the shores of Kamchatka. The first insignificant rise of water level in the bay occurred 45 minutes after the occurrance of the earthquake. Weak variations of the water level in the port were observed over a period of almost 12 hours. According to a report by an old resident of "Walrus" Bay, a small tsunami wave also approached that point. Some time after the earthquake the water in the coastal zone dropped off approximately 6 meters from the mean water level and then rose 1.5 to 2.0 meters above it.
("Earthquake on Kamchatka", by G. P. Chertnykh, Priroda, No. 12, 1959, p. 111)

Chinese Describe Type-581 Seismograph

An article giving information on the design, construction and testing results of the Type-581 seismograph has been published in the November issue of the Chinese scientific periodical, Acta Geophysica Sinica.

The Type-581 seismograph is intended for recording small local earthquakes. It consists of a pick-up, amplifier and a recording system. The pick-up is a pendulum (horizontal or vertical) of the usual electrodynamic type. The amplifier is of the capacitance-resistance coupled, push-pull type, and the recording system consists of a recorder head with stylus writing on smoked paper.

The frequency characteristic response curve and phase characteristics are shown in figure 12 (not reproduced here). The stability of the instrument (amplifier) was given particular attention. Figure 11 (not reproduced here) shows the small variation of the magnification indicator, V_0, of the instrument during 9 months of continuous operation at Station Peking. It also shows that during the first 6 months, V_0 dropped less than 2% monthly. Correction can be easily made by determination of V_0 at suitable time intervals.

Figures 13, 14, and 16 (not reproduced here) are reproductions of actual records of the seismographs. Figures 15 and 16d (not reproduced here) are records made by a similar instrument in which transistors instead of electronic tubes were used.
("Design, Construction and Testing Results of the Type-581 Seismograph," by Hsu Shao-hsien, Institute of Geophysics and Meteorology, Academia Sinica; Peking, Acta Geophysica Sinica, Vol 8, No. 2, 1959 November, p 109-122)

Soviet Report on Seismic Studies in China

An article in the Chinese scientific periodical Acta Geophysica Sinica, written by B. A. Petrushevskiy, Institute of the Physics of the Earth, Academy of Sciences USSR, deals with studies of the seismicity of Chinese territory.

The region under consideration consists of several zones geologically dissimilar and of complex structure. The seismicity of this zone is dependent on a number of factors. The tectonic movement of this region while not very great is, however, sometimes very high as in the case of the Hai-yuan earthquake of 1920.

It is possible to distinguish 5 separate large structural complexes in the region being considered on the basis of pecularities in the development of the tectonic movements. These 5 are the Nan Shan mountain range and the K'u-K'u-noerh ridge, the T'ien-t'ai zone, the A-la-shan massif, the Wu-wei to Shan-tan zone, and the Ho-lan Shan zone. Four of the 5 large structural complexes are closely related to each other. The epicenters were located partially inside and partially outside the boundaries of the complexes. A true understanding of their seismo-geological characteristis can be expected only by a joint study of these complexes.
("Studies of the Seismicity of Territory People's Republic of China", by B. A. Petrushevskiy; Peking, Acta Geophysica Sinica, Vol. 8, No. 2, November 1959, p 97-104)

VI. OCEANOGRAPHY

Sedov Sails on New Scientific Voyage

The Soviet hydrographic ship Sedov has sailed from the Baltic Sea on a new scientific voyage in the Atlantic Ocean according to an item in the newspaper Pravda. The item states that this is the world's largest sailing ship. It has a displacement of about 7,000 tons.
("In a Few Lines," Moscow, Pravda, 12 May 60, p 4)

The "VYTYAZ" in the Pacific

by V. Monchenko, Junior Scientist of the Institute of Zoology, Academy of Sciences Ukr. SSR

The curious gaze of man is penetrating deeper and deeper into the mysteries of the universe. The time is not far off when the earthling will put his foot on the surface of other celestial planets. But our planet still conceals within it quite a few unexplored areas, and the solution of these problems will continue to challenge the human mind for a long time.

The International Geophysical Year in which scientists from 65 countries took part has recently come to an end, and on 31 December 1959 the scientific observations under the program of the so-called international geophysical cooperation were completed. Under that program the soviet ship VITYAZ was scheduled to engage in scientific work in the Pacific to the southeast of the Japanese islands in July-September 1959. Needless to say, I was enthusiastic about the offer to participate in the expedition of the VITYAZ from which so many scientific discoveries had been made.

Three VITYAZ'es of the Russian fleet

...After traveling by train from west to east almost all the way across the country, I saw the snow-white hull of the expedition ship for the first time. Spelled out on the aft side in old slavic letter was the word VITYAZ. When we were assigned to our cabins and laboratories, I went on deck to get a good look at the ship. The ship's boatswain volunteered to be my guide. But we had time to visit only some of the laboratories. There were 14 of them, including an isotopic, meteorological, geological and several biological laboratories with close to 70 scientists working in them during the trip.

On the main deck my attention was attracted to huge tarpaulin-covered machines. The boatswain explained that those were powerful winches that can be used for lowering instruments and equipment to a depth of 11,000 meters. And during such operations the ship can remain motionless as the special equipment, not found on any other ship in the world, makes it possible for the VITYAZ to lower its anchor to a great depth.

A veritable floating institute and the largest scientific-research ship in the world, the VITYAZ was named after two Russian ships which had gone down in the history of geography and oceanology. The first was a propeller corvette by that name; Miklukho-Maklay, the famous geographer and ethnographer, sailed on it in 1871. The other was a sail-propeller corvette on which Adm. S. O. Makarov engaged in his famous research work in oceanology in the 90's of the last century.

'...There is always a solemn moment as a ship puts out to sea. There was a command "anchors away!" and a little while later "slow ahead". We finally entered the dense darkness of the Sea of Japan.

Ahead of us were a month and a half of expeditionary work...

Ocean Currents

The VITYAZ rapidly crosses the Japanese in an easterly direction in less than a day. On the next day we enter the wide Tsugaru strait. To the right of us is Honshu and to the left Hokkaido, the largest of the Japanese islands. Ahead of us are the vast spaces of the ocean, the largest in the world, carelessly named "The Pacific" by Magellan. We became convinced of Magellan's mistake a little later when we were caught in three violent typhoons — the readers may recall the recent press reports about the thousands of victims in Japan and the hundreds of ships washed ashore.

For awhile the ocean was placid and really "pacific" (quiet), and the water clear and azure. That contributed to our successful work. The point is that two huge ocean currents run through that particular place in the Pacific: The Kurile (in Japanese: Oyashio, "the ancestral current") and the Kuroshio ("blue current") which play an important part in determining the climate and weather of the adjacent areas in Asia.

It was the purpose of our expedition to study the structure and movement pattern of these currents.

Hydrobiologists at Work

The plan of our department was to study the fauna of Oyashio and Kuroshio and find the organisms whose very presence might be indicative of a particular current. Only such slow-moving organisms as plankton can be easily carried along with the current. We used thin silk plankton nets to catch them. A special device makes it possible to close the net at the desired depth thereby catching the plankton only at a particular layer of water.

But we were interested not in the deep sea denizens alone. Creatures inhabiting the upper layers of water also get caught in the trawling operations.

The seamen who always crowded around our place of work were asking endless questions about the odd-looking sea creatures. The vitryltsya (sail fish) are the main object of attention. We explained that those were the syphonfory(?), intestine-less creatures. A miniature triangular sail is attached to an oval-shaped flat object with a diameter up to 12 centimeters floating on the surface of the water. These very tiny creatures use that sail in swimming on the surface of the water. Curiously, the syphonofory can put up their sails against the wind and swim in the "desired" direction.

But the Portuguese boats (name of a fish) are not very popular with the seamen. You must watch your hands when pulling out a trawl or a netful of fish when those creatures are among them. Their bite is like a bee sting or a stinging nettle burn. Suspended from the air-filled bubble that steers the creature with the wind is a large number of long and very thin tentacle-feelers with stinging tips that paralyze the smaller creatures to be used for food by these queer-looking objects.

Light Attracts the Catch

Life on the boat goes on at a measured pace. Different devices are lowered into the ocean depth every 20 hours: bathometers, trawl nets and plankton nets. The daily worksheets are rapidly filled with figures and notations. The ship then resumes its sailing for another 8-9 hours and comes to another stop. This went on day in and day out until the storm interrupted the work for two-three days. At night the seamen off duty would relax by fishing. They would lower a powerful electric light into the water which attracted a large variety of sea denizens. Leisurely swimming past the light across the illuminated area are medusae and yaks... reflecting the soft vivid green light for a long time... A silver-colored saypa suddenly approaches the light... But this is not what attracts the seamen. Every now and then they hook a shiny sayra or a blunt-nosed korifena which keeps changing its color from brown to white. Such a catch would be the envy of any fisherman...

Someone pulled a sea urchin onto the deck. It immediately begins to pant aloud and inflate its white belly as if intending to frighten us. In its natural habitat this fish always resorts to such tricks as a defense against its enemies. When this fails to check the enemy, he would most likely put out his sharp bristles that cover his entire body. Incidentally, these bristles are nothing more than the scales of its ancient predecessors changed in the process of evolution.

But most frequently caught are the flying fish. These are very odd creatures. A thin diaphragm strung between the side fins is used as a "wing."

The fish steps up its speed in the water, then jumps out and glides with the wind for several dozen meters. Sometimes it propels itself on the surface of the water; powerful movements of the tail accelerate its speed and it continues its flight. The fish can thus fly 150 and even 200 meters. Attracted by the electric light, it occasionally jumps into the air and flies toward the ship. In such cases it hits against the ship and, apparently stunned, drops to the water lying there motionless. It is then fished out by the seamen with nets attached to long cords.

They drop their nets with unsurpassed skill straight on the fish. My first unsuccessful attempts to gain proficiency in this respect were met with good-natured jokes. The seamen tried to help me by advice or personal example.

On the Biography of the Octopuses

The improvised lesson is suddenly interrupted by an outcry. Look, octopuses!!! Dozens of nets are dropped into the water. Following them with my eyes I noticed a number of fast torpedo-shaped creatures; their sharp movements frighten the surrounding fish into panic scattering them in all directions in search for safety. Some of the seamen were very surprised when we, the zoologists, told them that the octopus propels itself on the same principle as a rocket. By releasing a powerful stream of water through a special funnel-like opening, the creature moves in the opposite direction. It can change its direction and make sharp turns by turning the funnel opening.

The octopuses feed mostly on fish. When pulled out of the water and up on the deck, they would eject a dense black fluid, sepia, which they ordinarily use as a camouflage when forced to flee. The octopus uses that fluid to create what looks like a smoke screen and escapes under its cover.

And how about tasting the octopus, someone inquired. It is eaten by the coastal population in Italy, Japan and other countries. It is even considered a delicacy. We finally prevailed upon the cook to prepare that "dish" for us. He was at first somewhat reluctant but finally agreed to do it. The roasted octopus turned out to be delicious. It tastes a little like a juicy mushroom.

("The Vytyaz in the Pacific" by V. Monchenko, Kiev, Znanya ta Pratsyie, No. 4, April 1960, pp 18-19) CPYRGHT

VII. ARCTIC AND ANTARCTIC

Inauguration of the Arctic Drift Station "Severnyy Polyus-9"

The following is the full text of a TASS dispatch datelined Leningrad on 29 April:

"Today the chief of the new scientific drift station 'Severnyy Polyus-9', V. A. Shamont'yev, in a special radiogram sent to the Arctic and Antarctic Institute, reported on the solemn inauguration of the drift station. The state flag of the USSR was hoisted over the ice floe and a rally was held".

"The camp of the 'SP-9' is laid out in the midst of the ice floe. Four hutments, a mess hall, and a galley have been constructed there for the polar specialists. A meteorological station has been established and the 'SP-9' has begun to transmit its first meteorological reports".

("The State Flag of the USSR Has Been Hoisted Over the 'SP-9' ", Sovetskaya Aviatsiya, 30 April 1960, p. 4)

The Wind and Temperature Regime in the Lower Stratosphere Over Antarctica — A Full Translation from the "Reports of the Academy of Sciences of the USSR"

The well-known fact of great seasonal variations in temperature at heights of 20 to 25 km above the region of the South Pole has received full confirmation during the period of the International Geophysical Year. The recorded absolute values for temperature, however, have exceeded expectations: the minimum temperature in the stratosphere over the pole (-93°) was observed on 17 July 1958 at the 25 and 30 mb surfaces (approximate elevation — 23 to 25 km), while the maximum (-1°) was observed on 24 October of the same year at the 5 mb level. For the 25-30 mb levels the maximum temperatures ranged between -20 to -25°; the amplitude of seasonal changes of temperature over the South Pole therefore attains 70°. We note, as can be seen from Figure 1, that the seasonal difference was 55° even for the mean monthly values of temperature at this elevation; this is almost twice as great as the seasonal differences in temperature at the earth's surface and is almost four times as great as in the middle troposphere at an elevation of 4 to 5 km.

Obviously, such sharp seasonal changes in the temperature regime in the stratosphere over Antarctica will be expressed in the conditions of air circulation at these heights, substantially different in winter and summer. Whereas the circum-polar plateau and the Antarctic continent as a whole remain year-round a source of cold for the lower layers of the atmosphere

and the horizontal temperature gradient in the troposphere at no time changes its direction, the picture in the stratosphere is substantially different: the upper layers of air over Antarctica are warmer in summer than over the temperate and low latitudes although there are exceedingly low temperatures here in winter, as at the earth's surface. (In passing it might be mentioned that approximately the same minimum temperature, about -90°, was recorded in the stratosphere and at the earth's surface in the central part of the continent.)

As can be seen from Figure 2, air circulation in the lowermost stratosphere, near the 200 mb surface, is characterized at all seasons of the year by a cyclonic vortex (sometimes several), centered over the circumpolar plateau, but not over the geographic pole itself. In the winter the center of the low is usually situated over the western half of the plateau, while in the summer it is displaced in the direction of the Ross ice shelf (but it may also appear over other regions adjoining the pole as, for example, in April). The resultant wind over the station Amundsen at the 200 mb level is westerly, $20-40^{\circ}$, that is, from the direction of the Weddell Sea, from the Atlantic Ocean. In the summer months Pacific Ocean winds at this level are most commonly observed, but in general the summer air currents over the central regions of Antarctica are unsteady in direction; this fully corresponds to the status of the temperature field at this season of the year. The horizontal temperature gradients in the stratosphere over the Antarctic are very small: the Atlantic Ocean and Indian Ocean sectors are only a few degrees warmer than the Pacific Ocean sector.

If we examine the higher levels, represented by the 50 mb maps (Figure 3), we discover that there is no year-round cyclonic vortex over the Antarctic, as exists in the lowermost part of the stratosphere. The differences in the height of the 50 mb surface in December and January above the individual Antarctic stations is so insignificant that to all intents and purposes it is difficult to discover any systematic inclination of this surface. The velocity of the latter over a majority of the stations is small (10-15 km/hr) during the summer season.

The velocity of the wind over Antarctica increases perceptibly in the spring and fall in comparison with summer, but in the center of the low it remains low; on the periphery, however, the wind velocity exceeds 100 km/hr even on the mean monthly maps. Over the individual stations it often attains values of 250 km/hr in the cold season and sometimes even reaches 500 km/hr (for example, the station of d'Urville on the Adelie Land coast, 18 September 1958).

Strong westerly winds at great altitudes or the stratospheric jet stream encircling the Antarctic continent, have a seasonal character. It arises in

the fall, in March, when the atmosphere above the polar plateau cools off and the interlatitudinal temperature gradient becomes pronounced. In winter, as the difference in the temperature of the atmosphere over the Antarctic continent and the oceans of the temp rate latitudes increases, the intensity of the jet stream increases. It attains a maximum in the spring, in October, before the return of the Sun and the associated heating of the atmosphere (which does not occur simultaneously at all latitudes); in October the Sun has not yet influenced the region of the circumpolar plateau. In November the velocity of the wind begins to decrease; this is caused by a gradual heating of the air over the central regions of the Antarctic continent which leads to a decrease in the values of interlatitudinal temperature gradients.

It is interesting to note that the winter stratospheric cyclonic vortex over the Antarctic is quite symmetrical in respect to the focus of the cold in the stratosphere above the continent; its center is not over the geographic pole, but approximately over the Pole of Inaccessability, that is, over the center of the continent. This indicates that at this elevation the circulatory and temperature regime in the atmosphere to a considerable degree depends on the underlying surface; the influence of the latter makes itself felt more strongly than the influence of the astronomical position of the Sun. Apparently above the 50 mb surface the dominant influence of the underlying surface will not be so evident or will become totally imperceptible; at this level the mean monthly temperatures in the region of the geographic pole are already the same as at the station of Sovetskaya, the closest to the Pole of Inaccessability, although at lowerlying levels they were somewhat greater. This is easy to observe by an examination of Table 1, which gives the mean monthly temperature values for the 200 and 50 mb levels for a group of stations situated along a line running through the South Pole from the Falkland Islands to Campbell Island in the Pacific Ocean. This same table enables us to evaluate the differences in the temperature regime of the stratosphere over the high and temperate latitudes of the Southern Hemisphere, as was discussed above.

Table 1

MEAN MONTHLY TEMPERATURE OVER ANTARCTICA AT THE 200 AND 50 mb SURFACES IN 1958

(in degrees Celsius)

Name and coordinates of station	200 mb				50 mb			
	Jan	Apr	July	Oct	Dec	Jan	Apr	Oct
Stanley, 52°S., 58°E.	-52,5	-53,5	-57,7	-60,2	—	—	—	—
Orcadas, 61°S., 45°E.	-44,7	—	-64,2	-63,4	—	—	—	—
Deception, 64°S., 64°E.	-42,8	-53,7	-68,5	-65,7	—	—	—	—
Halley Bay, 76°S., 27°W.	-42,7	-55,0	-74,5	-71,8	—	—	—	—
Ellsworth, 78°S., 41°W.	-43,0	-55,6	-72,9	-70,7	-34,8	-36,8	-63,0	-64,8
South Pole, 90°S.	-44,0	-52,9	-73,0	-72,8	-34,8	-36,8	—	-65,3
Sovetskaya, 78°S., 88°E.	-45,1	-58,5	-75,4	-72,6	-34,5	—	-61,0	-65,3
McMurdo, 78°S., 167°E.	-43,3	-53,0	-68,2	-66,2	-35,0	-37,2	-60,0	-56,3
Hallet, 72°S., 170°E.	-41,8	-51,5	-67,8	-61,2	-36,7	-38,6	-56,0	-58,9
d'Urville, 67°S., 140°E.	-40,9	-50,5	-65,2	-59,3	-32,5	-32,2	-46,0	-35,0
Campbell, 53°S., 169°E.	-49,3	-52,3	-59,5	-53,0	—	—	—	—

Note: The 50 mb data for July are missing. Inasmuch as there are no data for this level for the station of Sovetskaya and a number of other stations for January, December data is provided.

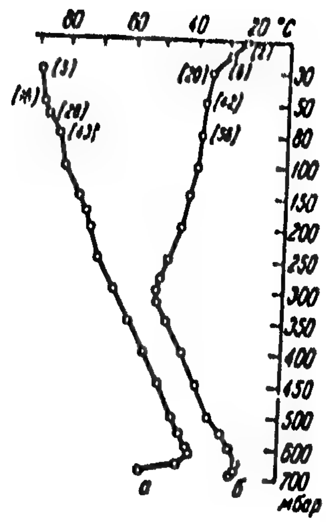
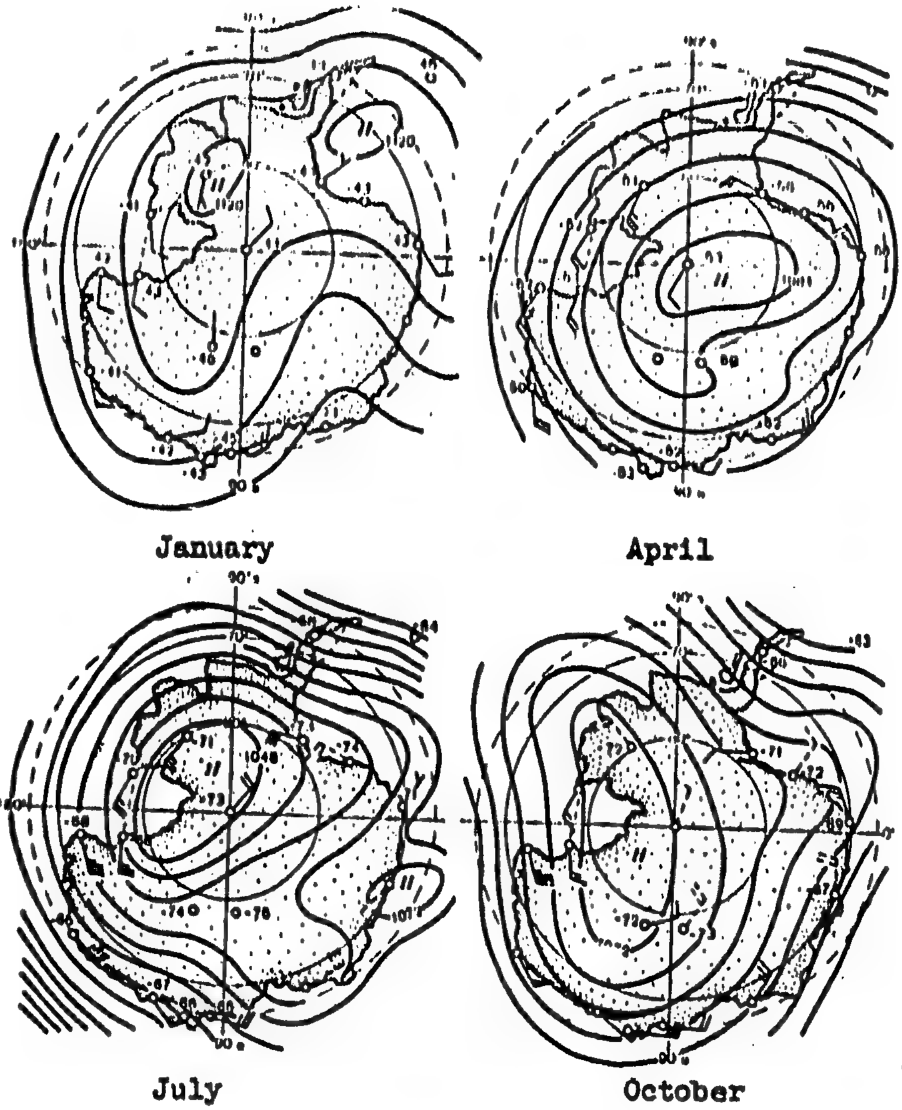


Fig 1. Mean monthly temperature over stations at the South Pole in July (a) and January (b) 1958. The number of radiosondes reaching a given altitude are shown in parentheses.



H cyclone

−43 temperature

1048 contour lines

Resultant wind

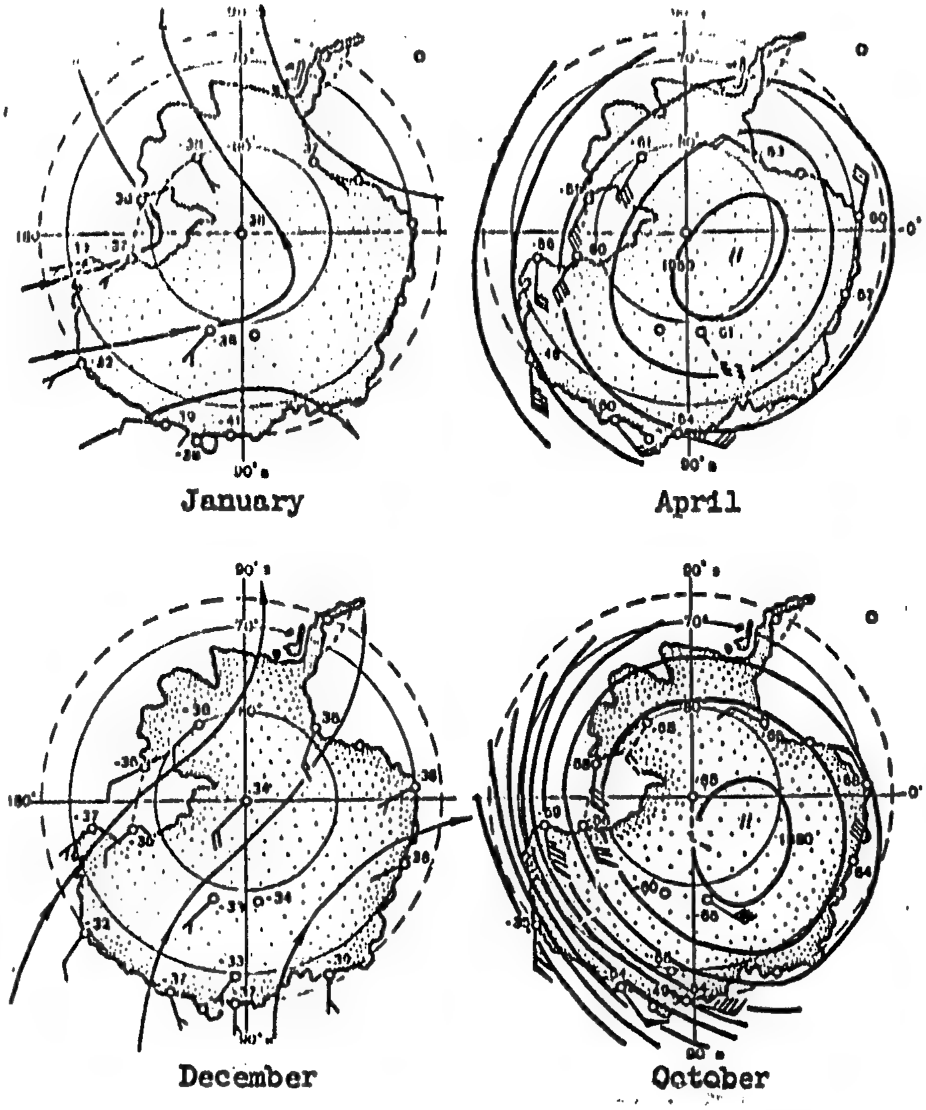
50 knots

15 knots

5 knots

resultant wind determinded from incomplete data

Fig. 2. Circulation and temperature regime at the 200 millibar surface over the Antarctic in different seasons of 1958.



H cyclone

−38 temperature

wind current

1950 contour line

Resultant winds

100 knots — 5 knots

25 knots

resultant wind determined from incomplete data

Fig 3. Circulation and temperature regime at the 50 millibar surface over the Antarctic in different seasons of 1958

("On the Wind and Temperature Regime in the Lower Stratosphere Over Antarctica", by P. D. Astapenko, Doklady Akademii Nauk SSSR, Vol. 131, No. 3, 1960, pp. 616-619).

Further Report on Determination of Absolute Elevations in Antarctica — Another Full Translation from the "Reports of the Academy of Sciences of the USSR"

One of the principal tasks of research in the Antarctic is the determination of the relief of the sixth continent, in particular, the elevation of the ice dome which occupies a large part of its surface. These determinations and the drawing of a hyposometric map of Antarctica are independent geographical problems, but a number of other problems in meteorology, glaciology and gravimetry are closely associated with them.

In actuality, without knowing the precise values for the elevation of the continent, we cannot solve the problem of the position of the lower boundary of the ice cover, that is, we cannot determine the subglacial relief of the continent. Without knowing elevations, we cannot determine the true field of air pressure over Antarctica, without which it is impossible to solve the problem of air circulation in this region of the globe.

But all determinations of elevations in Antarctica, and especially in the interior regions of the continent, are subject to great difficulties. The fact is that ordinary instrumental levelling, providing great accuracy in determinations, is presently impossible in Antarctica on lengthy traverses due to extremely great difficulties in respect to climate; ordinary barometric levelling is inexact due to our lack of knowledge of the values for the pressure anomalies constantly existing over the continent, caused by the thermal influence of the Antarctic ice mantle. Moreover, the latter method is generally undesirable when solving meteorological problems because it is this anomaly that needs to be determined, based on a knowledge of the precise values for the elevations of the area. That is the reason why a great deal of attention has been devoted to this problem and why methods have been developed to make it possible to exclude the influence of the pressure anomaly on the value of the determined elevations of the continental dome.

The method of determination of elevations from an aircraft flying beyond the limits of the distorting pressure field of the cold layer of air has proven very effective. The altitude of the aircraft in this case was determined by the ordinary barometric formula while the distance from the aircraft to the surface of the dome was determined by radio altimeter. The difference in these values yielded the height of the surface of the dome above sea level. This method was used for the first time on the first expedition; the elevation of Pionerskaya, the first station in the interior, was accurately determined by this method. This method, in perfected form, was used extensively by V. A. Bugayev on the third expedition. Figure 1 shows the pattern of flights made over Antarctica.

As a result of all these measurements the expedition's flagship navigator, B. S. Brodkin, who participated on the principal flights, has compiled the first hypsometric map of a considerable part of Eastern Antarctica. The accuracy of the measurements made, satisfying the requirements for the solution of certain problems, has proven inadequate for the solution of a number of others. For the purpose of increasing the accuracy of determinations, the Institute of Applied Geophysics of the Academy of Sciences of the USSR has conducted a search for a new method of determining elevations; this method should not be dependent on the measurement of atmospheric pressure. It has been proposed that we determine the height of an aircraft flying over the dome by means of the continuous recording of its vertical movements or vertical accelerations from the moment of take-off.

The vertical speed of the aircraft, recorded on a tape moving proportional to time $\underline{t}$, is some function $u = f_1(t)$, while its vertical acceleration is $du/dt = f_2(t)$. The desired value for the height of the aircraft $\underline{H}$ is determined by integration, that is, by determination of the area of the curve of the vertical velocity of the aircraft or by successive double integration of the dependence of vertical acceleration on time

(F) (1)

The measured height of the area above sea level is determined in this case by the difference in the values of the height of the aircraft and the distance from the aircraft to the surface, determined by the radio altimeter.

The vertical velocity of the aircraft can be continually recorded by a variometer — an aircraft instrument determining this element of movement by the velocity of change in pressure. This is a quite reliable method (within fixed limits), not depending on the absolute value for pressure; stricter determinations, however, are made from the vertical accelerations, recorded by a special accelerometer.

The accuracy of determinations of height by this method will depend in turn on the accuracy of two measurements: measurements of the height of flight and measurements of the distance from the aircraft to the surface. Calculations show that the accuracy of the first measurements made during a multi-hour flight can be held to 10 m.; the accumulated error can be determined when returning to the initial point of flight. Radio altimeters can also provide the indicated accuracy. Presently available radio altimeters do not give a totally clear reflection from a surface of loose snow but this shortcoming in the method can be eliminated if a low-level flight is made (or, if possible, a landing). In such cases there is of course no need for using a radio altimeter.

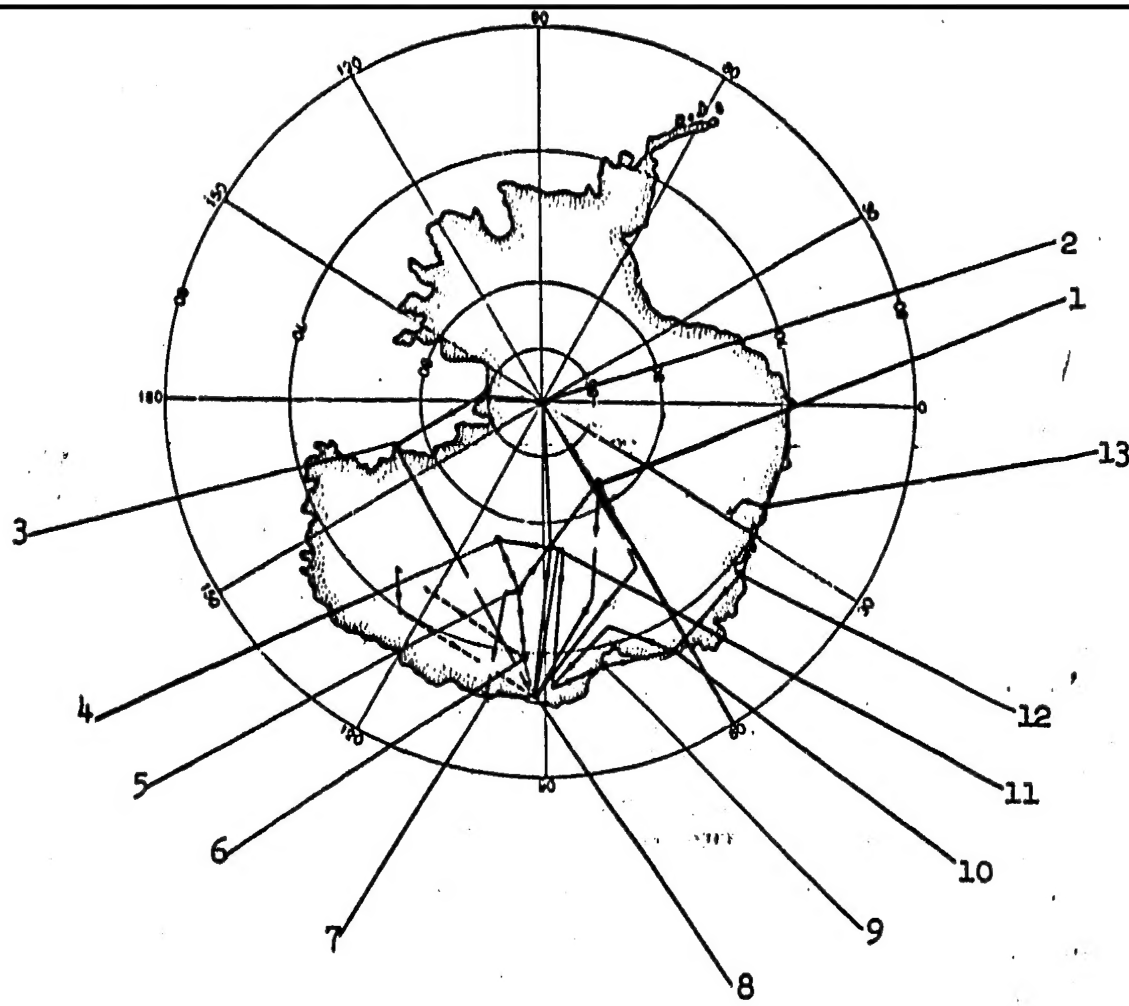
The two methods for the determination of the vertical velocity are not sufficiently precise during plane take-offs and landings; therefore the instrument must be turned on after take-off, the initial height being determined by means of a radio altimeter. This is especially convenient to do when flying over the surface of the sea. It is also necessary to proceed in this manner before landing after returning from a flight.

The principle described above forms the basis for an instrument developed by A. M. Gusev and N. I. Lozovskiy. Using the instrument in the final stages of the third and the beginning stages of the fourth expedition, A. M. Gusev made determinations of the elevation of the ice dome of Eastern Antarctica along the route indicated by a dotted line in Figure 1. The flight route lay over Wilkes Land in the direction of Victoria Lane; it lasted about 13 hours. This was the first such flight ever made in this region and the ice dome had been completely unstudied. During the flight V. A. Bugayev and V. I. Shlyakhov also determined the elevation of the ice dome by the earlier method of using an aneroid barometer.

We derived the elevations at different points along the flight route by the processing of the instrumental recordings. The maximum elevation proved to be at its most distant point, which we reached 6 hours after departure from Mirnyy. Thereafter the area began to drop off. In Figure 2, 1 shows the profile of the area along the route Mirnyy-Pionerskaya, the most distant point of the flight, with the coordinates 72°23' S., 130°30' E; 2 -- the altitude of the flight.

The elevations determined by the new method proved to be somewhat greater than the elevations determined by the aneroid barometer along the entire flight route to the point indicated. The maximum discrepancy was 122 m. This discrepancy must be regarded as correct since temperature observations showed that the aircraft was at all times within a cold layer of air.

It is interesting to note that the value for the discrepancy changed in complete correspondence with our concepts of the influence of the pressure anomaly caused by the presence of the cold layer of air over the Antarctic dome. In those cases when the aircraft flew high above the surface, that is, close to the horizontal isobaric surface, the discrepancies in determinations by the two methods decreased, but when the aircraft descended the discrepancies increased. It should be noted that both methods have their positive and negative aspects and for the time being they should be regarded as supplementing one another.



(1) Pole of Relative Inaccessability
(2) Amundsen-Scott
(3) McMurdo
(4) Vostok
(5) Komsomol'skaya
(6) Pionerskaya
(7) Oazis
(8) Mirnyy
(9) Davis
(10) Mawson
(11) Sovetskaya
(12) Showa
(13) Baudouin

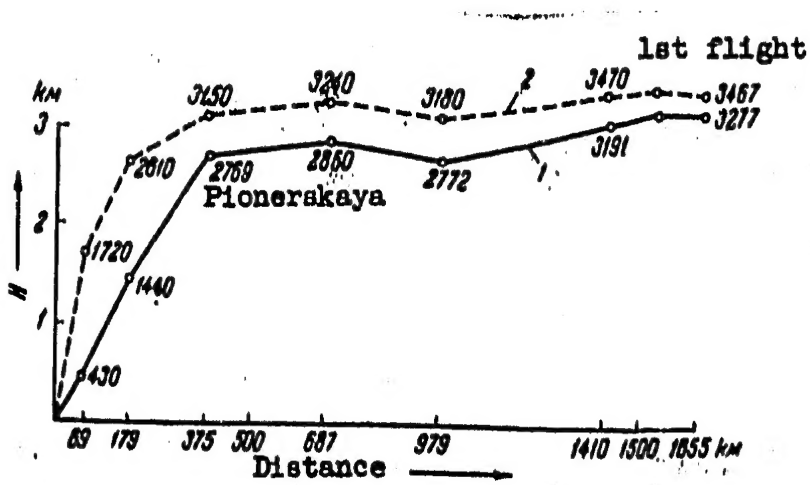


Fig 2. Profile of the locality (1) and the altitude (2) of the flight to Wilkes Land

("Toward the Determination of the Absolute Altitude of the Antarctic Ice Dome", by A. M. Gusev, Doklady Akademii Nauk SSSR, Vol. 130, No. 3, pp. 530-532)

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